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More than a Mean: Broadening the Definition of Employee Performance

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To the Graduate Council:

I am submitting herewith a dissertation written by Amanda M. Baugous entitled "More than a Mean: Broadening the Definition of Employee Performance." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Industrial and Organizational Psychology.

David J. Woehr, Major Professor

We have read this dissertation and recommend its acceptance:

Robert T. Ladd, Mandyam M. Srinivasan, Michael D. McIntyre

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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MORE THAN A MEAN:

BROADENING THE DEFINITION OF EMPLOYEE PERFORMANCE

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Amanda M. Baugous

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DEDICATION

This dissertation, and all of the time and energy put into completing it and the Ph.D. program, is dedicated to my family. It may have taken ten years, but if you see this in print, I hope that you know that every day of each of those years, was spent with the goal of making you proud. To my parents: Tom and MiChelle, for loving me and encouraging me to set my sights very high. I realize you have no idea what I was really working on all this time, and are really confused about what took so long, so I am especially grateful for your unconditional and continuous cheerleading. To my in-laws: Chuck and Virginia, whose generous support and stoic belief in my abilities provided an invaluable source of strength. To my husband: Rob, who signed onto this relationship oblivious to the long-term havoc my graduate school experience would cause in our marriage, yet stuck with me anyway. Most of all, this dissertation is dedicated to my boys, Charlie and Sam. Above anything else, my goal is to live my life in a way that will make you proud of your mom.

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ABSTRACT

The detrimental impact of performance variation within the mechanics of an organizational process is well established within the field of Operations Management. Furthermore, determining the causes of and resolutions for variability in the performance of system mechanisms has become a key focus for improving organizational performance (Womack & Jones, 1996). This dissertation extends this research as it examines the prevalence and nature of human performance variability within organizations, its relationship with individual mean work performance, and its impact on individual- and group-level performance within a manufacturing context. Moreover, this study investigates the relationships between individual difference variables (conscientiousness, cognitive ability, and three facets of work ethic) and individual work performance variability.

Results indicate that individual performance variability does exist in moderate to high levels within organizations. Additionally, the relationship between individual mean performance and within-person performance variability is not significant. Therefore, the two metrics may be providing different and important information about employee performance. Hierarchical regression results reveal that the average performance level of group members significantly predicts group level performance; however the relationship is moderated by the average level of individual performance variability of group members.

Finally, though individual performance variability is apparent in the study, the hypothesized relationships between individual performance variability and the individual difference measures were not supported. However, post hoc analyses reveal a number of potential avenues to pursue in determining whether individual differences (e.g., Agreeableness, Neuroticism, Extraversion, etc.) may be related to individual performance variability. These findings provide a starting point for research into the impact of human performance variability on individual and group level performance. The implications of these results and directions for future research are discussed.

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CHAPTER 1

INTRODUCTION

In the last twenty-five years, a shift in management ideology has swept across countries, industries, and companies. The bureaucratic and centralized management style of traditional organizations in the United States has been encroached upon by more participative and innovative management philosophies. The crux of these new approaches to management is continuous improvement via the elimination of any waste, and/or variability, within any organizational process (Womack & Jones, 1996). Success, as defined by such philosophies, hinges on an organization's ability to reap incessant systems improvement via variance reduction in the pursuit of efficiency and quality.

This emphasis on efficiency and quality has been embraced by many U.S. organizations as a potential source of competitive advantage given the increasing difficulty encountered with the erratic US economy, the rapidly expanding global economy, and phenomenal increases in productivity due to emerging technologies. Past approaches to dealing with such challenges (e.g., downsizing, cost cutting, etc.) have fallen short of resolving these dilemmas. Instead these tactics often result in larger, more pervasive concerns like declines in quality and productivity (e.g., Brown, Arnetz & Petersson, 2003; Jalajas & Bommer, 1999) both due to the resulting reduction in workforce and resources, as well as to the emotional and social

implications experienced by employees, including decreased organizational commitment and increased stress (e.g., Clay-Warner, Hegtdvedt, & Roman, 2005; Knudsen, Johnson, Martin & Roman, 2003; Luthans & Sommer, 1999) stemming from the elimination of perceived job security. Therefore, organizations are increasingly receptive to philosophies and practices that allow them to operate more effectively in terms of productivity and quality with fewer resources without the long-term consequences of short-term fixes.

Specifically, in recent years the importance of demonstrating the value of human resources has become even more significant as corporations struggle with increasingly competitive markets, globalization, and the fluctuating economy. Evaluating employees in terms of their contribution to an organization's strategic objectives and metrics is becoming increasingly important as companies grapple with allocating scarce resources to best benefit the organization's long-term competitive position (Boudreau & Ramstad, 2003). The valuation of human resources within Industrial and Organizational Psychology is referred to as utility analysis and typically attempts to quantify the value of employee performance in terms of financial impact (Roth, Bobko, & Mabon, 2002). In general, the assumptions are that a) summary indices (usually a calculated mean) of employee performance are an accurate representation of employee performance, b) employee performance has calculable monetary value, and c) if between-person variation on the summary indices can be explained then that information allows higher performing employees to be chosen or retained over lower performing employees thereby benefiting the organization

financially. However, Industrial and Organizational Psychology has had inconsistent results in its attempts to quantify utility both in terms of accuracy and acceptance by decision-makers (e.g., Cabrera & Raju, 2001; Latham & Whyte, 1997). Often the attempts to resolve these issues revolve around how job performance is assigned monetary value (Roth, Bobko, & Mabon, 2002). However, it could also be argued that it is the first assumption -- that summary indices are an accurate representation of employee performance -- upon which the subsequent assumptions rest, that may be flawed. Boudreau, Sturman, and Judge (1994) point out that the typically simplified, univariate approaches to measuring employee performance in most utility analyses are unrealistic for most organizational settings. Rather, they suggest that a broader, more multivariate, conceptualization of performance may be more applicable.

Furthermore, evidence that this first assumption may not be reliable can be found within research in the field of Operations Management, which has established that performance variability (e.g., equipment reliability, changes in equipment set-up, supplier dependability, raw materials quality, etc.) has a significant detrimental impact on organizational productivity. Therefore, within this field, measures of mean work performance have been supplemented with the inclusion of performance variability metrics to generate a more comprehensive definition of work performance. That is *effective performance* may be more accurately defined as the interaction between mean performance and performance variability, rather than mean performance alone.

However, Operations Management has not typically included assessments of human performance variability in its research (Doerr, Freed, Mitchell, Schreisheim, &

Zhou, 2004). Incorporating within-person performance variability in the definition of employee performance may serve as a way to more accurately assess true employee performance. Moreover, it may also provide a viable route to making more accurate evaluations of human resources value to organizations. Therefore, this dissertation seeks to gauge the existence of human work performance variability within an organizational setting and to evaluate its influence on individual- and group- level work performance.

This dissertation begins with an overview of Industrial and Organizational Psychology's perspective on the issues inherent to using work performance as a primary criterion and continues with a description of how many organizations have expanded the definition of performance to include performance variability in conjunction with performance level. The first objective of this dissertation is to evaluate the existence, severity, and pervasiveness of within-person work performance variability in a field setting. Additionally, the relationship between individual performance variability and mean performance is examined to determine whether the two are related or could be providing different, possibly complementary, information regarding employee performance. Also, the relative impact of both individual performance mean and individual performance variability on group-level productivity is examined. Finally, it evaluates the usefulness of common measures of individual differences (i.e., cognitive ability, work-related attitudes, and personality facets) from the Industrial and Organizational Psychology literature to predict individual performance variability.

CHAPTER 2

REVIEW OF THE LITERATURE

The Job Performance Criterion

Since its very beginnings, the field of Industrial and Organizational Psychology has focused on job performance as the primary criterion of interest. However, defining and measuring job performance has presented a number of obstacles in and of itself. Choosing criteria representative of the target domain, operationalizing and measuring those criteria accurately, establishing the generalizability of results, and presenting results in terms important to both researchers and practitioners are just a few of the issues complicating advancement (Austin & Villanova, 1992).

One issue is that the choice of criterion in research is often limited to performance metrics that are readily available or obtainable – typically managerial judgments of performance – rather than measures that objectively represent work performance. Also, the operationalization and measurement of work performance often culminates with a summary indicator of individual performance, whether obtained subjectively (e.g., managerial ratings of performance) or objectively (e.g., electronic measures of productivity or quality) that can be used to compare employees and/or candidates to one another for administrative decision-making purposes. Therefore, historically, the goal of Industrial and Organizational Psychologists has

been to generate measures to account for the variance found across employees or job candidates on these work performance metrics. That is, the *coefficient of validity*, or correlation between the predictive measure and the performance measure, has established itself at the very heart of Industrial and Organizational Psychology research because it allows the calculation of the amount of variation accounted for by the predictor in between-subject work performance measures.

However, the use of judgmental assessments by managers leaves performance appraisal subject to extraneous influences, error, and rater biases clearly documented in research (e.g., Kingstrom & Mainstone, 1985; Holzbach, 1978). Moreover, the focus on summary ratings and validity coefficients is founded on the assumption that more of a presumably good thing is better; that the primary concern of human resource interventions should be increasing summary performance levels, and that organizations will function better if they hire, and retain, the "best" performers possible as a result of top-down selection based on valid predictors.

Job Performance as a Dynamic Criterion

However, despite a targeted focus on validity, the nebulous nature of the job performance domain, combined with measurement error in both predictors and criterion, have resulted in relatively small prediction capabilities, inconsistent findings, and often shortfalls in the observed impact of HR interventions. A number of researchers have argued that these problems are the result of a deficiency in the job performance domain. Rather than a simple, static criterion, they have presented

evidence that job performance is a complex and dynamic criterion influenced by factors such as time, individual characteristics, and specific characteristics of the situation. For example, Henry & Hulin (1987) argued that validity coefficients and utility estimates based on more simplified models of performance run the risk of over-inflation, thereby constraining the accuracy and usefulness of validity coefficients and utility analysis as decision tools.

Factors like time and individual differences have had some success in better expanding our understanding of the work performance domain. In particular, the influence of time, as a result of training, maturity, or experience, has been adequately established, and generally accepted, as an dynamic influence on the validity and usefulness of measures to predict future work performance in many job situations (e.g., Ployhart & Hakel, 1998; Hofmann, Jacobs, & Baratta, 1993; Hulin, Henry, & Noon, 1990; Murphy, 1989). Also, individual characteristics like cognitive ability (e.g., Ackerman, 1989) or goal-orientation (Dweck, 1989) have been found to influence the validity coefficients of predictive measures of work performance. Finally, the organizational environment (e.g., Caldwell & O'Reilly, 1990), and specifically the appraisal environment (e.g., Sackett, Zedeck, & Fogli, 1988), seems to influence validity coefficients as well, supporting the notion that work performance may be a more complicated criterion than originally assumed.

Sackett, Zedeck, and Fogli's (1988) research is particularly relevant to the discussion of individual performance variability as a means to further expand our understanding of the work performance domain. In their research, they deconstructed

the work performance criteria using a "typical" versus "maximum" performance continuum that classifies the performance appraisal environment in terms of its situational characteristics. In their typology, *maximum performance* refers to performance that occurs in a situation where an employee is aware of being monitored, has accepted the standard or instructions for the task, and is able to remain focused on the target task throughout the evaluation. On the other hand, *typical performance* refers to performance in a more representative situation in which individual work performance is evaluated in a more typical work setting and over a longer period of time. The results of their study indicate that the correlation between typical and maximum performance is low, implying that typical and maximum performance situations do not result in the same information about employee performance. Therefore, typical and maximum performance levels may have differing relationships with given predictors. Moreover, they also revealed that judgmental assessments of performance are actually more highly correlated with maximum work performance indicators than they are with typical, day-to-day work performance.

The aforementioned study makes a significant contribution to the understanding of the performance domain, and directing Industrial and Organizational Psychology toward looking at performance as a dynamic criterion. It also challenges the assumption that summary performance ratings made by an observer are an accurate representation of the range of day-to-day individual work performance.

Performance Variability as a Facet of the Job Performance Domain

Sacket, Zedeck and Fogli's (1988) findings also set up the case for two additional issues. First of all, while it clearly demonstrates that employees tend to vary the level at which they perform a task, it does not consider the true opposite of maximum performance (i.e., minimum performance) and its implications for work performance as a criterion. Furthermore, it may be important to also consider the impact of minimum to maximum performance variation, in and of itself, on higher levels of productivity.

As discussed in the next section of this dissertation, performance variation is a variable of interest in Operations Management research because of the significant impact that performance variation has on metrics of system and organizational productivity. As such an important variable, performance variability provides a potential area for Industrial and Organizational Psychologists to not only better define job performance and ultimately better predict it, but also begin to integrate the complementary research foci within Personnel and Operations Management research.

To briefly illustrate the impact of individual work performance variation, one must first accept that employees typically do not work in isolation; rather their performance most often contributes to the performance of a system. For example, on a manufacturing line, the level of performance of one individual determines, in part, the level of performance of the next stage. If the first employee is working slowly or producing defective product, then necessarily they will slow the next station. If the

first employee is working more quickly than the next, then product may start piling up in the process making it vulnerable to damage, loss, or obsolescence.

If it is assumed that individuals perform without variation, the criterion of interest in these scenarios should be overall level of work performance, with a focus on elevation at lagging stations, and reduction in between-person performance variability. That is, choosing the speediest, or highest performing, candidates and/or improving incumbent performance would be the goal of any selection or training intervention. However, if any of these inter-dependent individuals vary their level of individual performance, even slightly, the impact of the variation can be felt multiplicatively throughout the process by the subsequent stations in the system. Therefore, while overall performance certainly influences productivity; variability in individual performance levels also has an important impact. Thus, the effective performance of an employee, regardless of how productivity is defined, should be viewed as an interaction between individual mean level of work performance and individual work performance variability.

Performance Variability in Industrial and Organizational Psychology

Of course it should be noted that, though limited in scope, some research in Industrial and Organizational Psychology has attempted to incorporate within-person performance variability into the performance domain. As early as 1957, Fiske found evidence that individuals tend to show idiosyncratically consistent levels of performance variability across similar tasks. Berdie (1969, 1961) also determined that

individual work performance variability showed significant levels of consistency, particularly across hand-eye coordination tasks. Both studies attempted to initiate a stream of research into the correlates of individual task performance variability.

More recently, a number of publications by Kane and colleagues (Kane, 2000; Kane, 1997, Kane, 1983; Kane & Bernardin, 1982) have endorsed approaching performance appraisal from a performance distribution perspective in which within-person variability in work performance is incorporated as supplemental information to the summary ratings. Kane's work proposes that performance be evaluated in terms of the percentage of time that an individual performs a task at varying levels of performance. He argues that evaluating individual performance levels, as a percentage of time, may be a stronger, more accurate, evaluation format than more subjective formats. Newman, Krzystofiak, & Cardy (1986), and more recently Steiner, Rain, & Smalley (1993), support Kane's argument that performance variability provides important information regarding individual work performance. Both studies found evidence that performance appraisal ratings were significantly influenced by performance variability information. Furthermore, a limited number of empirical studies, mostly within educational contexts, have illustrated that Kane's distribution oriented assessment approach performs at least equivalently to a summary performance rating approach in terms of construct validity and freedom from measurement error (Woehr & Miller, 1997; Deadrick & Gardner, 1997).

While these studies support the importance of considering individual work performance variability, as well as the methodological soundness of Kane's approach;

this research has not significantly changed the way that individual work performance is evaluated in Industrial and Organizational Psychology literature or practice. One possible explanation for this is that the significance and influence of individual work performance variability has not been firmly established in Industrial and Organizational Psychology research.

Performance Variability in Operations Management

However, performance variability has become an important factor in Operations Management research and often plays a crucial role in operations decision-making. The shift in concentration from mean level of performance to the interaction between mean performance level and individual performance variability has occurred in response to changes in the nature of business in general. A general overview of the competitive environment and current mindset of organizational decision makers follows.

A Survey of Current Business Foci

Concentration on improving systems seems to be prevalent across industries, particularly as an increasing number of organizations attempt to shift their focus from short-term financial performance to operational excellence as a way to achieve and ensure long-term competitive advantage. Such a focus opposes the traditional philosophy used to run businesses in the United States in which each business function, and ultimately each employee, works to serve independently derived goals

without intentional consideration of the impact on the system as an interdependent whole. However, transitioning to an emphasis on system excellence requires mindset shifts for both organizations and researchers from a local, reactive perspective to a more proactive, systems perspective.

A number of management strategies have evolved over the last 40 years, and particularly rapidly in the US over the last 25 years, which concentrate on continuous operational improvement as a means by which organizations can capture and maintain a leadership position within their respective markets. Practices and processes entitled Six Sigma, statistical process control (SPC), lean management, integrated supply chain management, applied theory of constraints, et cetera, while somewhat distinctive in practice, all espouse the value of becoming "lean" by streamlining processes, reducing variation, and addressing organizations, and in many cases entire supply chains, as inter-reliant systems in order to maximize long-term competitive advantage.

Lean Philosophy

Originally conceptualized by Toyota Motor Company as a way to sustain dramatic resource shortfalls following World War II, the Lean approach quickly established itself as an effective business philosophy and key component to sustained competitive advantage. The most important tenet of the Lean philosophy is the continuous search for ways to eliminate non-value added, or "wasteful"; steps via reductions in the resources, effort, time, or capacity consumed in the completion of any organizational process (Imai, 1986). Such improvements could involve actions to

reduce materials handling, upgrade machinery for efficiency or productivity, reduce defects or scrap work, shrink inventories, standardize work practices, or streamline systems (Ohno, 1988). In fact, Lean proponents contend that organizations can not only maintain but even improve operations and customer satisfaction with "half or less of the human effort, space, tools, time, and overall expense" by focusing on waste and variation reduction (Womack & Jones, 1996).

The Lean philosophy represents a transformation not only in how an organization functions operationally, but also in how performance is measured and how resource allocation decisions are made. Traditionally, organizations have focused on maximizing the use of machinery and employees based on the assumption that higher utilization of valuable resources is beneficial. In order to justify the expense of equipment and payrolls, companies have run plants, equipment, and employees as hard as possible, choosing to house excess inventory and rework defective products, rather than reduce the demands on the system (Womack & Jones, 1996). However, the new lean approach to management endorses a revision of this mentality, opting instead to apply quantitative assessments of performance and statistical analysis of available performance data to set organizational objectives based on the factors like the exact demands and requirements of customers, the most prudent production schedules to balance inventory costs with operational expenditures, the process least likely to result in expensive defects, and the variability in productivity. The heavy reliance on analysis and process evaluation is evident in the increasing usage of statistical procedures, like statistical process control charts and Six Sigma guidelines,

to direct operational decisions. Moreover, the reliance on hard data for decision-making extends to the tactical and strategic levels in its usage to provide direction for organizational decisions like supplier and distributor selection, research and development endeavors, and the choice of product offerings and markets. Traditional metrics concentrate primarily on increasing utilization and quantity, whereas more current performance metrics focus more on profitability via reduced *manufacturing lead time*, which is defined as the time allotted by the organization for a desired quality product to navigate the organization's operations routing system (Hopp & Spearman, 1996). In order to streamline lead times, organizations are forced to assess, not only their organization as an holistic, integrated entity, but also their role within an integrated supply chain (from supplier of raw materials to finished goods inventory and/or consumer receipt) and focus on improving the system as a whole, rather than direct their attention to maximizing their performance as an independent entity. This perspective involves evaluating all functions of an organization in terms of their contribution to the organization's, and ultimately the supply chain's, achievement of strategic objectives and metrics.

Lean through Variance Reduction

While the mindset has begun to shift from functional silos to holistic organizational systems, the role that performance variability plays within a system also has been highlighted. Rather than concentrating on mean work performance, or mean performance increases, the use of detailed statistical analysis has revealed the

significant detriment that work performance variability can impose on a system's performance. In fact, variance reduction in systems has become the prevalent priority in many manufacturing and service organizations throughout the U.S. and the world. Variation in a process has been referred to as the 'root of all evil' in a process (i Six Sigma, 2000; Srinivasan, 2004) because Operations Management research has clearly demonstrated that even slight levels of variation in anything from consumer demand to machine calibration will significantly reduce the efficiency, and ultimately long-term viability, of an organization (Womack & Jones, 1996; Ohno, 1988). Furthermore, variability builds and propagates throughout a system causing more and more significant problems as a process continues.

The impact of variance can be found in any business process -- any system in which the required activities are interdependent. Variance can be categorized as either uncontrollable (i.e., random) or controllable (e.g., equipment malfunction). The more variance in a system, whatever its cause, results in higher levels of required inventories (i.e., finished goods inventory, work-in-process inventory, and raw materials) in order to effectively meet demand. Larger inventories result in higher defect rates and longer *production cycle times*, or the average time from release of a product into a system until it reaches completion and enters inventory holding (Hopp & Spearman, 1996), and therefore longer lead times (Womack & Jones, 1996). Longer lead times mean a longer wait for customers, which could result in loss of market to faster competitors. Therefore, business decision makers are faced with the

task of choosing process interventions based on their capability to reduce variance in the system, and ultimately improve the organization's performance.

Human Performance Variability

Typically Operations Management research has focused primarily on variability as a result of equipment capabilities, levels of inventory, and changes in demand and has generally ignored the influence of employee performance when making operations decisions. In fact, Hopp and Spearman (1996) point out that "…poor operations decisions are generally not misguided because of a lack of appreciation of subtle psychological details; they are frequently wrongheaded because of a wholesale inattention to the fundamental aspects of human nature (366)." Hopp and Spearman (1996) go on to discuss a number of variables (e.g., motivation, ability, burnout) that may effect differently the mean performance across individual employees in a system, thereby constraining the effectiveness of operations decisions made in response to optimization models based solely on materials and equipment considerations.

Also, mention has been made that, in addition to between-person differences in mean work performance, variability in individual employee performance also may impact organizational productivity. Unfortunately, empirical documentation of such an impact is lacking, despite acknowledgement by at least a few researchers that employee performance variability may, in fact, be a leading cause of problematic variance in organizational systems (Doerr, and Arreola-Risa, 2000; Zavadlav,

McClain, and Thomas, 1996). For example, Doerr and Arreola-Risa (2000) found that a particular production line was required to overstaff by nearly 20% primarily due to the varying levels of employee performance. Furthermore, Boudreau and Ramstad (2003) suggest that individual work performance variability in positions typically characterized by low complexity and/or low pay -- characteristics relevant to the employee rather than the machine used -- may have "pivotal effects" on systems highlighting the importance of implementing human resource practices with strong utility at this organizational level. Finally, another study revealed a direct relationship between number of employees and system-level performance variability (Doerr, Klastorin, and Magazine, 2000). These findings highlight the fact that individual employee performance variability may be of primary interest to decision makers, but also that the larger (thus requiring additional employees) or more complex the process the more detrimental the impact. Nevertheless, when Operations Management research does incorporate employee performance in the evaluation of system performance it is often incorporated as mean-level individual performance metrics, despite the incorporation of variability information for most other parameters (e.g., equipment variance, supplier variance, etc.).

Doerr, Mitchell, Schriesheim, Freed, and Zhou (2002) address this inconsistency conceptually in their development of a model of flow line performance that incorporates both between-employee and within-employee performance variance, as well as the impact of work flow policies set by the organization. Doerr, et al. (2002) describe a number of work flow policies, the most commonly modeled of

which include process decisions such as batch size (the number of items that move through a process together), buffer size (the amount of work in process allowed to accumulate between stations), and boundary rules (the rigidity of workload assignments). The propositions offered by Doerr, et al. (2002) focus on the interaction between employee performance variability and boundary rule policies and its impact on line performance. Not only has their paper offered up an important integrative model illuminating the interdependence of processes and people within organizations, but also the potential impact of within- and between-employee variance on system performance.

Despite the understanding that performance variability impacts the productivity of a system, the focus of Industrial and Organizational Psychologists has been primarily on explaining, or accounting for, between-person performance variability rather than on designing and supporting HR systems that aid organizations in reducing within-person performance variability. However, from an Operations Management perspective, a well-informed manager may choose a machine that performs invariably at a lower average performance level over a machine with a higher mean performance but also higher variability, because the impact of the variability may undermine system productivity. Much the same, because of the interdependence among employees found in many work environments, it may be useful for Industrial and Organizational Psychologists to investigate job performance as a function of individual mean performance and individual performance variability, rather than focusing on top-down decision making based on average performance

levels and validity coefficients. In order to initiate this stream of research, it is important to fully understand the variables of interest when evaluating the impact of an individual's performance on the system in which they work.

The Coefficient of Variation

Operations Management research evaluates the mechanical system variation by utilizing the *coefficient of variation (CV)*, a relative measure of variability calculated by dividing the standard deviation of performance by mean performance (Hopp & Spearman, 1996). The coefficient of variation can be assessed on a single machine, on an interdependent line, an entire system, or at the organizational level. For instance, the coefficient of variation may be used to assess the variation of a single machine's performance on an assembly line as well as on the time between concept development and market entrance of new products. It is an invaluable, normalized metric that can be used to compare the utility of alternatives when making decisions at all organizational levels.

The value of the CV metric is its ability to provide a standardized, comparable metric for process times throughout the organization. Furthermore, Operations Management research has demonstrated that the coefficient of variation of an individual machine or production line has a direct relationship with production cycle time, a key metric in calculating productivity in terms of throughput. *Throughput,* or the average output produced by a machine or system or business unit (Hopp & Spearman, 1996), is a primary source of revenue for organizations. According to

Little's Law (Little, 1992), as cycle time increases work in process (or WIP) inventory (a primary source of cost for organizations) must also increase to maintain desired throughput levels. Essentially, cycle time, which is directly effected by the coefficient of variation, has a direct role in the assessment of organizational productivity and, therefore, is used to assess any component of a system in which time is a primary influence on effectiveness.

Because of its relationship to cycle time, the coefficient of variation is a critical metric to making decisions within an operational context. The coefficient of variation can be assessed and compared, in addition to mean or overall performance, for each machine or human working in a system, thereby providing a more accurate assessment of the impact, or effective performance, of individual work performance on higher level productivity metrics, and ultimately on organizational revenues and costs.

Impact of Front-Line Variance

In addition to the level of individual performance variability, the location of the individual performance variability within the organizational structure has important implications for system performance. Specifically, the earlier in an interdependent system that variability occurs the larger the effect down the line. This is particularly evident in f*ront-line positions*, characterized in this dissertation as those that have direct interaction with either the products or services offered by the organization (e.g., manufacturing line workers, bank tellers, hair stylists), or have direct interaction with the customer (e.g., customer service representatives).

Therefore, front-line positions have a significant, and arguably primary, influence on the health of an organization. Doerr, Klastorin, and Magazine (2000) point out that, though distal in their relationship to a general metric of organizational performance, the role of front-line employees is pivotal to organizational success. This impact is primarily due to the role of the front-line in producing core products or fulfilling core services for the organization and its customers. That is, performance variability in quality or speed on the front-line can be felt at the organizational level in terms of productivity and service.

Performance disruptions, in the form of mean performance levels, as well as variability in performance (e.g., quality/speed of output, absenteeism, turnover), can have critical consequences for an organization (e.g., quality problems, dissatisfied customers, lost business). For example, customer service representatives (CSR) may take 10 minutes on average to resolve customer complaints. When within person variance on that metric is low, managers can easily plan the number of CSRs to have staffed in order to meet demand. However, if that 10-minute average varies dramatically (e.g., 50% of the time it takes 5 minutes, the other 50% of the time it takes 15 minutes) then managers have more difficulty determining the appropriate staffing count. Understaffing could have significant consequences as customers may be queued for lengthy waits, while overstaffing would result in unnecessarily high labor costs, as well as bored or underworked employees.

Given that front-line employees usually make up a large proportion of an organization's workforce, the potential for significant detriment as a result of

performance problems at this level is high. The findings of Doerr, Klastorin, and Magazine (2000) articulate this direct relationship between the number of employees in a system and the system's production variability. Therefore, this particular level of the organization should be a primary target for HR initiatives focused on elevating both mean performance and reducing variance in performance.

The "Middle Ground" – The Link between HR and Organizational Success

Boudreau and Ramstad (1996) highlight the importance of "illuminating the middle ground," by which they mean articulating the links between HR interventions and organizational objectives. The leap made by most Industrial and Organizational Psychologists, from employee performance level to an organizational effectiveness is sizable, and extremely difficult to quantify when evaluating performance solely at the individual mean performance level. Boudreau and Ramstad (2003) argue that articulation of this link is glossed over in traditional Industrial and Organizational Psychology research and needs to be "illuminated."

The impact of employee performance on system performance, and ultimately on organizational effectiveness, seems to be one relationship that needs to be clarified. Given the problematic impact of variability in a system recognized by Operations Management research, and the growing dependence on interdependent teams of people in the workplace, it seems that Industrial and Organizational Psychology could begin to illuminate the individual performance-organizational performance link with the expansion of the employee performance domain by

incorporating measures of individual performance variability and evaluating its impact on group-level productivity.

Furthermore, the inclusion of the coefficient of variation in performance evaluation allows a clearer link to a specific outcome of significant importance discussed earlier in this dissertation: cycle time. In many situations, cycle time, mediates the relationship between mean system performance and organizational performance. Moreover, cycle time can be converted to a number of metrics including monetary terms like revenue and costs, as well as non-monetary terms such as lead time, productivity, quality, and inventory levels. A link between individual performance and a metric like cycle time, and ultimately lead time, would provide a clearer, more objective connection between individual performance and system performance, and ultimately organizational effectiveness. Establishing this link in the Industrial and Organizational Psychology research may provide a viable avenue for new, and possibly more accurate and acceptable, utility estimates for human resource interventions proposed by Industrial and Organizational Psychology research.

Summary

Though generally it has not included human performance variability in its research, Operations Management has established that even slight reductions in variance within a system can have a significant impact on the performance of the system, ultimately impacting group- and organizational-level productivity. Moreover, as discussed, a relatively small body of research in Industrial and Organizational

Psychology has begun to evaluate the existence and potential implications of individual performance variability. Therefore, it is the objective of this dissertation to further the investigation of within-person performance variability as a means toward expanding the employee performance domain. Furthermore, other objectives are to examine this more comprehensive definition of employee performance in terms of its relevance to group-level productivity, as well as its relationship with individual difference variables such as cognitive ability, work-related attitudes, and facets of personality).

CHAPTER 3

THE PRESENT STUDY

This dissertation proposes to address four research questions in pursuit of revealing any role that within-person performance variability may play as a variable of interest in Industrial and Organizational Psychology research. Within Operations Management research, variation is characterized as a root problem in systems performance. Performance fluctuations in equipment or supply reliability have proven detrimental to the performance of systems in Operations Management research. However, research on the impact of fluctuation in human performance is limited in both Operations Management and Industrial and Organizational Psychology research.

Research Question 1

Historically, Industrial and Organizational Psychology has concerned itself with explaining the variance in performance across individuals. However, performance tends to be defined as a snapshot evaluation of performance over a given time period. The implicit assumption being that the performance rating assigned effectively captures the individual's organizational contribution. However, Operations Management research has pointed out the significance of looking beyond a snapshot evaluation of performance to evaluate its contribution to the system in which it operates. Doerr, et al. (2000) has transferred this idea from equipment reliability to

human reliability. They point out that individual work performance variability could have significant impact on a system in terms of costly overtime, and conceptually suggest that such fluctuation could have a large and detrimental impact on system performance. Therefore the first question of interest is:

R1. To what extent does within-person performance variability exist within an organizational context?

Research Question 2

The second concentration of this dissertation is to evaluate the relationship between individual mean performance and individual performance variation. If mean performance and individual performance variability are highly correlated then incorporating both metrics in the assessment of performance would not add a significant amount of information above and beyond the information provided by the traditional focus on mean performance. However, if individual mean performance and individual performance variability are not correlated, then the two metrics may be providing different information about performance, both of which may have significant implications for system and organizational productivity.

R2. What is the correlation between mean performance and performance variability?

Research Question 3

Should individual mean performance and variability in individual performance offer different information to business decision makers; the question then arises as to what extent each metric provides useful information regarding effective group-level performance. Industrial and Organizational Psychology research has focused heavily on snapshot ratings of overall performance while Operations Management research has demonstrated the importance of looking beyond the mean and focusing on individual performance variability and its implications. Therefore, the third question for this dissertation is to evaluate the relative impact of the individual mean performance of group members and the individual performance variability of group members on overall group productivity within an organizational context.

R3. Does organizational productivity data support the relationship between mean performance and performance variability articulated by Operations Management research? That is, what is the relative impact of the mean performance of individual group members and the performance variability of individual group members on group-level productivity?

Research Question 4

Finally, the use of variance as a criterion variable changes the nature of predictive measures used to evaluate job candidates and incumbents. Thus far research has done only a cursory investigation of the antecedents of on-the-job

performance variability, though medical research has show significant relationships between performance on physical tasks and individual characteristics like age (Rabbitt, Osmen, Moore, & Stollery, 2001), frontal lobe lesions (Stuss, Murphy, Binns, & Alexander, 2003). Specifically, Pan, Shell, and Scheifer (1994) supported the direct relationship between fatigue and work performance found by West (1969), in their study of the interaction between humans and computers. They found that worker fatigue and boredom is related to speed variability, though not to accuracy variability. Judiesch and Schmidt (2000) briefly discussed the possibility that intra-individual performance variability may be a function of individual motivation (e.g., incentive systems, personal goals, etc.); however the very existence of intra-individual variation was generally viewed simply as an obstacle to obtaining accurate between-worker variability observations. Nonetheless, this discussion of individual characteristics that may influence performance variability opens the door for further investigation of intra-individual performance variability and its correlates.

R4. Can individual difference measures predict individual performance variability?

Hypothesis 1: Conscientiousness

Characteristics such as conscientiousness or reliability have proven inconclusive regarding their relationship to general performance (Driskell, Hogan, Salas, and Hoskim, 1994; Hogan, Hogan, & Murtha, 1992) with some studies finding small but significant positive correlations (Timmerman, 2004; Salgado, 2003; Barrick,

Mount, & Judge, 2001; Tett, Jackson, & Rothstein, 1991; Barrick & Mount, 1991), others finding no correlation (Ridgell & Lounsbury, 2004), and still others finding negative correlations (Schell & Reilly, 2004) between conscientiousness and summary indicators of individual performance. More recent studies and meta-analytic reviews of Conscientiousness as a predictor of individual performance have found that inconsistent correlations could be explained as a result of a non-linear (LaHuis, Martin, & Avis, 2005) or curvilinear relationship between conscientious behavior and performance (Tett & Burnett, 2004; Tett, Jackson, Rothestein & Reddon, 1999). That is, in some circumstances individuals scoring high on conscientiousness may find their attention to detail and organization puts them at a disadvantage, particularly when required to meet strict deadlines, while it may benefit them when quality is the primary performance metric. However, in terms of individual performance variability, attentiveness and thoroughness are valued over quantity or simple speed, therefore Conscientiousness is hypothesized to have a consistently negative and significant relationship with individual performance variability.

H1. Conscientiousness is negatively related to individual performance variability.

Hypotheses 2-4: Work Ethic

Work ethic generally refers to an individual's internalization of accountability for one's work and the belief that hard work is valuable. Research on work ethic and

its impact on important organizational metrics has historically waxed and waned. However, recent interest in the area has been piqued as a result of concerns that the work ethic of the U.S. workforce may be on an overall decline (Hill, 1997; Lipset, 1990). It has been argued that such a decline may contribute to lower levels of work performance and general commitment to work (Yandle, 2003; Shimko, 1992). The focus of the work ethic construct on commitment to and accountability for individual work seems, at least theoretically, directly relevant to the ability to work efficiently and reliably and without irrelevant distraction, as assessed when measuring individual performance variability.

A recent monograph on the topic revealed that work ethic might in fact be multi-faceted. Miller, Woehr, and Hudspeth (2002) found evidence that work ethic may actually consist of seven correlated but unique subscales. In their criterion validity study, three components: Self-Reliance, Leisure, and Delay of Gratification contributed to the prediction of supervisory performance ratings. However, three other seemingly related components: Hard Work, Centrality of Work, and Wasted Time were not related to supervisory performance ratings in their study. Hard Work refers to the belief that hard work is valuable, Centrality of Work refers to an intrinsic motivation to work, and Wasted Time measures attitudes towards productive use of time at work. All three appear to relate to the efficiency, reliability, and dependability inherent to reduced performance variability, and, therefore, may find their function in predicting objectively defined individual performance variability to a larger extent than subjectively derived supervisory ratings of overall performance. Furthermore,

Tang's (1989) research found that individuals scoring high on work ethic exerted effort on tasks regardless of task challenge, whereas individuals scoring low on work ethic were less likely to exert effort unless the task was challenging. This research is particularly relevant in this context because the types of jobs carrying the weight of lean management philosophies are at the line-level and typically characterized by less complex, standardized tasks. Therefore, the potential of work ethic as a predictor may become increasingly valuable to employers especially if this characteristic proves increasingly hard to find in applicants, yet strongly correlated to important performance metrics like performance variability.

H2. Attitudes toward Hard Work are negatively related to individual performance variability.

H3. Attitudes toward the Centrality of Work are negatively related to individual performance variability.

H4. Attitudes toward Wasted Time are negatively related to individual performance variability.

Hypothesis 5: Cognitive Ability

Conscientiousness and work ethic theoretically could tap into the characteristics necessary to work with little individual performance variability. However, general measures of cognitive ability have historically proven useful in predicting overall work performance. While research has found more encouraging

results in predicting performance in more complex jobs, measures of general intelligence have also maintained high validities relative to other predictors for all job types (Hunter, 1986; Schmidt & Hunter, 2004; Schmidt & Hunter, 1998). Specifically, Schmidt and Hunter's (1998) validity generalization study places the corrected validity coefficients between intelligence and general performance in unskilled jobs at 0.23 and semi-skilled jobs at 0.41.

Overall, cognitive ability has generally established itself as a measure of whether or not an individual has the intellectual capacity to do a particular job, which may not be closely related to an individual's consistency on work tasks as measured by individual performance variability. Therefore, it would be expected that while cognitive ability may predict mean performance levels, as is typically measured by a summary performance measures, it most likely has a different relationship with the variability of individual performance.

Generally individual performance is viewed as an interaction between ability and motivation (Pinder, 1998) that may also be moderated by environmental forces within the organization (Blumberg & Pringle, 1982). Therefore, it should be noted, assuming a supportive environment, that toward the extremities of the cognitive ability continuum, individual performance variability may be impacted due to the influence of individual ability and motivation at these levels. That is, very low cognitive ability would likely constrain individual performance in terms of both mean and variability because motivation would not be able to compensate for very low cognitive ability. On the other hand, if cognitive ability is high, though expected mean performance may

be high, the relationship with individual performance variability may be moderated significantly by motivational influences. That is, simpler, more structured, or less challenging tasks may not engage consistently those with a higher level of cognitive ability resulting higher potential for individual performance variability. Therefore, it is hypothesized that the higher the level of cognitive ability the higher the likelihood of individual work performance variability.

H5. Cognitive ability is positively related to performance variability.

Conclusion

Shifting the valuation of within-person variability to a focal variable has a number of potential impacts. First of all, in the limited number of studies evaluating the use of performance distributions as assessment tools, the ratings derived were less prone to measurement error than those derived using judgmental assessments (Woehr & Miller, 1997). Therefore, these benefits of using distributional assessment, in conjunction with the acknowledgement of the impact of performance distributions on system and organizational effectiveness, indicate that the more comprehensive view of performance may be a fruitful research avenue for Industrial and Organizational Psychology. Additionally, the use of individual performance variation as a criterion variable influences the nomological network of performance, particularly which variables may be most useful for predicting employee work performance. Moreover, the inclusion of individual performance variation, in addition to mean performance,

requires a proportional change in the evaluation of HR systems in terms of utility estimates. Finally, the incorporation of variance in Industrial and Organizational Psychology research begins to build a bridge between the issues of interest to Industrial and Organizational Psychologists and key criteria sought out by organizational decision makers, particularly variance reduction and its impact on system productivity and organizational effectiveness.

CHAPTER 4

METHODOLOGY

Participants

Individual Data

The participants in the study included 82 bargaining-unit manufacturing employees from a life support equipment production facility in the Midwest. According to self-identification data, of those employees who reported, 92.7% reported themselves as male, while 7.3% reported as female. Furthermore, 91.5% reported themselves as White, while 8.5% included themselves in other race categories. The average age of the participants was 40.67 years (SD=8.04) with a range of 26.36 years to 57.30 years. The average company tenure of the participants was 38.70 months (SD=5.80) with a range of 6.51 months to 124.11 months. Each employee typically worked with a specific group of co-workers manufacturing or assembling components for multiple lines of life support equipment used in hospitals as well as in military and commercial aviation. Participation in this study was voluntary.

Group Data

Each individual in the subject sample is assigned a work group by the organization. Within the dataset of 82 individuals, 16 workgroups are represented.

The number of group members representing each group varies from 3 to 6 group members with an average of 5 group members per group represented.

Measures

Individual performance measures, called efficiency statistics, were collected over a period of eight weeks. Furthermore, group-level efficiency statistics were collected over that same period of time. Finally, predictor data in the form of the Wonderlic Personnel Test, The NEO-PI-R, and the Multi-dimensional Work Ethic Profile (MWEP) measures were collected for each of the subjects.

Individual Efficiency Statistics

Efficiency statistics are performance measures derived electronically by the company. That is, products or components are scanned when work begins and then scanned again when work stops or is completed. Efficiency statistics are calculated by dividing an individual's *process time,* or time required to produce a quality product (i.e., the time between the start scan and completion scan) by the standard process time allocated by the company for that specific product. The organization then averages this ratio for each product completed over the course of one week to generate a weekly reported efficiency statistic. The goal of the efficiency statistic, therefore, is for employees to maintain an efficiency statistic of 1.00 indicating that they are producing quality product at exactly the rate required to meet organizational goals. An efficiency statistic of more than 1.00 indicates that the employee is working more quickly than

required, while a rating of less than 1.00 indicates that an employee is working more slowly than required. In this particular organization, employees working faster than the set pace are considered to be higher performers than those working at or below the set pace.

Group Efficiency Statistics

Group efficiency statistics are calculated in the same way that individual efficiency statistics are calculated, though they evaluate how efficiently interdependent groups are working to generate products. That is, each product is scanned when it enters the group for processing and again when it reaches completion. This is equivalent to the group's cycle time to make a product (i.e., time between start scan and completion scan) divided by the standard group cycle time set by the organization for that product. The ratio for each product worked on by the group is averaged over the course of a week to generate a weekly reported efficiency statistic.

Summary Individual Performance and Group Productivity Statistics

Efficiency statistics were averaged over the eight weeks in order to generate an overall indicator of average work performance for individuals and work productivity for groups.

Performance Variability Statistics

Performance variability was calculated by using the equation for the Coefficient of Variation (CV). This coefficient is generated by calculating the individual's standard deviation of performance over time divided by the individual's mean performance over the same time period. In this case, the individual's standard deviation of efficiency statistics over eight weeks was divided by the individual's mean efficiency statistic over the same eight weeks.

Group level variation was calculated in the same way. That is, the group's standard deviation of efficiency statistics over eight weeks was divided by the group's mean efficiency statistic over the same eight weeks.

Cognitive Ability

Cognitive ability scores were obtained from Wonderlic Personnel Test (WPT), which was administered during the organization's employment selection process for each position represented in the sample. The WPT is a 50 item, 12-minute, general cognitive ability assessment that includes math, spatial, and reading comprehension problems. It is scored by calculating the number of the final problem finished minus the number wrong or incomplete up to the final attempted problem. Scores can range from a low of 0, indicating no items were correctly answered within the 12-minute period to a high of 50 indicating that all items were correctly answered within the 12-minute period.

Personality

Conscientiousness was measured using the NEO-PI-R, a 240 item, untimed, personality assessment designed to assess five separate personality domains (Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness). Subjects were asked to complete the entire 240-item measure though only Conscientiousness was included in the proposed hypotheses.

Responses to all 48 Conscientiousness-related items were rated on a 5-point Likert-type scale (1=strongly disagree to 5=strongly agree). The sum total of an individual's response to the 48 items classified as Conscientiousness was calculated to generate a Conscientiousness score that could range from 48, indicating consistently strong disagreement with Conscientiousness-related items to 240 indicating consistently strong agreement with Conscientiousness-related items.

Work Ethic

In order to generate scores on Work Ethic, the Multidimensional Work Ethic Profile (MWEP) (Miller, Woehr, & Hudspeth, 2002) was administered to all subjects. The MWEP is a 65 item, untimed, assessment designed to evaluate an individual's agreement with items related to seven facets of work ethic. Subjects were asked to complete the entire MWEP measure, though only three of the seven facets: Hard Work, Centrality of Work, and Wasted Time were included in the proposed hypotheses. Responses to the MWEP questionnaire were made on a 5-point Likert scale (1=strongly disagree to 5=strongly agree). Responses to items associated with

each hypothesis-related dimension were summed to generate a dimension score ranging from 10 indicating consistently low endorsement of related items to 50 indicating consistently high endorsement of related items.

Procedure

Existing performance and cognitive ability data were drawn from the organization's human resources database for bargaining unit manufacturing employees. Employees from this bargaining unit were invited to complete the NEO-PI-R and Work Ethic questionnaires in a training room on the grounds of the organization during a set-aside time early in their workday. Both measures asked participants to respond to a series of statements by choosing a response on a 1 (Strongly Disagree) to 5 (Strongly Agree) scale. Both measures are untimed; therefore participants were instructed to work at a comfortable pace.

In exchange for participation, participants were allowed to take the duration of the assessment as paid time and were offered food and beverages while completing the assessments. Summary reports of the cognitive ability results, work ethic findings, and personality profiles were provided to those individuals who expressed interest.

CHAPTER 5

RESULTS

Descriptive Analysis

Initial analysis of the data set involved calculation of descriptive statistics for both the mean and coefficient of variation at the individual, aggregate group member, and workgroup levels. Generally, the collected data for each of these variables resulted in relatively normal distributions, with the exception of the individual coefficient of variation which was significantly and positively skewed (skew=0.926, $p<0.05$) and the workgroup level mean which was significantly leptokurtotic (kurtosis=2.997, $p<0.01$). Specific descriptive data for each of these variables can be found in Table 1, while graphic distributions of each variable are illustrated in Graphs 1 through 6 (Tables and Figures can be found in the Appendix).

Research Question 1

Research question 1 investigates the prevalence of human performance variability both at the individual and group levels. The standards used are as follows: CVs less than 0.5 are classified as Low Variation, CVs between 0.5 and 1.00 are classified as Moderate Variation, and CVs of more than 1.00 are classified as High Variation. At the group level, 44.70% of the groups fall into the Low Variation classification, while 55.3% fall into the Moderate Variation classification with a mean

of 0.495 (SD=0.102). At the aggregated group member level, 18.75% of the groups are classified as Low Variation, while 81.25% fall into the Moderate Variation classification with a mean CV of 0.564 (SD=0.139). Finally, among individual participations, 46.30% of individual participants fall into the Low Variation classification, 46.30% are classified as Moderate Variation, and 7.3% are classified as High Variation. The average variation at the individual level is 0.567 (SD=0.231). These results are summarized in Table 1. The results indicate a moderate to high level of performance variation occurring throughout a majority (53.60%) of the individuals who participated in this study, while 55.3% of the work groups demonstrated moderate variation in performance. The prevalence of moderate to high performance variation at all levels of human performance analyzed in this dissertation indicates that this may be a significant source of variability that bears further investigation regarding its influence on productivity and organizational performance.

Research Question 2

Research question 2 focuses on the relationship between the measure of individual mean performance and the measure of individual performance variability. In order to conduct this analysis, bivariate correlations were run between the variables: mean individual performance and the coefficient of individual performance variance. The relationship between individual work performance mean and individual work performance variability was not significant ($r=-0.193$, $p=0.082$). This result indicates that individual mean performance and individual performance variability

provide different information and that the two variables may be tapping into different facets of individual performance. Therefore the inclusion of individual work performance variability may extend our understanding of the employee performance domain and begs the question of its influence on subsequent process performance, as well as at higher levels such as group-level and organizational-level productivity.

Research Question 3

Research question 3 involves assessing the contribution to group-level productivity of the two individual variables: aggregated mean performance of group members and the aggregated coefficient of performance variability of group members; as well as their interaction. Descriptive statistics and correlations for these variables can be found in Table 2. The correlational analysis indicates that the aggregate mean performance of individual group members is not related to the aggregated mean performance variability of individual group members ($r=-0.205$, $p=0.446$) indicating, as was found in results for research question 2, that the two are measuring different aspects of performance at both the individual- and group-levels. Specifically, the aggregate mean performance of individual group members is strongly related to group level mean performance ($r=0.741$, $p<0.01$), though it is not significantly related to group level performance variability ($r=-0.147$, $p=0.587$). On the other hand, the aggregate mean performance variability of individual group members is highly correlated with group level variability ($r=0.873$, $p<0.01$) though not significantly related to group level mean productivity ($r=-0.434$, $p=0.093$). That is, while the

aggregate mean performance of individual group members is a strong indicator of group level mean productivity, aggregate performance variability of individual group members is a stronger indicator of the group's production consistency.

Operations Management research has supported the notion that effective performance is made up of more than the mean-level performance statistic, and must include consideration of performance variation because any type of variability places constraints on performance (Hopp & Spearman, 1996). Therefore, hierarchical regression was used to assess whether this principle also applied to human work performance. Regression analysis was used to reveal the impact of including the aggregate performance variability of group members in addition to the aggregate mean performance of individual group members, as well as their interaction, on the prediction of group level mean productivity.

In this data set, aggregate mean performance of individual group members is most strongly correlated with group level mean productivity, therefore it was entered into the predictive model first (R^2=0.549, $p<0.01$). However, when aggregate performance variability of individual group members was introduced into the additive model the prediction of group productivity improves (R^2=0.632, $p<0.01$) though model fit does not improve substantially (ΔR^2=0.083, ΔF=2.923, $p=0.11$). This is not surprising considering the statistically non-significant relationship found between aggregated performance variability of group members and group-level mean productivity. However, the inclusion of the interaction term significantly improves the prediction of workgroup productivity (R^2=0.767, $p<0.01$) with a significant

improvement in model fit (ΔR^2=0.218, ΔF=5.604, $p<0.05$). All three variables: aggregate mean performance of individual group members ($t=3.855$, $p<0.01$), aggregate CV of individual group members ($t=-2.972$, $p<0.05$), and their interaction ($t=-2.636$, $p<0.05$) contribute significantly to the prediction of group level mean productivity. These results are detailed in Table 3.

These results articulate a strong relationship between the mean level performance of group members and the productivity of their group. These findings also suggest that the relationship between group level productivity and the performance of group members is affected by the performance variation of group members. To examine this effect, a median split on aggregate group member performance variability was conducted to categorize the groups according to aggregate group member performance variation. Graph 7 illustrates the influence of group member performance variation. That is, high performance variability among group members seems to constrain group level productivity to a stronger extent than a low level of performance variability among group members.

Though the number of groups in this data set is relatively small, there is a clear difference in relationship between group level productivity and aggregate mean performance of group members when evaluated in terms of aggregate performance variability of group members. Furthermore, that most of the variation (76.7%) in group-level performance is accounted for by the mean performance of group members and the inclusion of aggregate performance variability of group members, indicates that extraneous factors of variability -- those outside of employee performance -- have

a relatively small impact on group-level performance for this work environment. Therefore, consideration of human performance variability as an influential source of detrimental variability within a system is warranted. Furthermore, the extent to which we can understand and explain employee performance variability could provide valuable information regarding the explanation of system- and corporate- level performance.

Research Question 4

Research question 4 queries the relationship of a number of individual difference variables with the individual coefficient of variation. In this case, four hypotheses were proposed. Correlations for all of the variables of interest in this dissertation can be found in Table 4. Furthermore, a summary of the hypothesized results can be found in Table 5.

Hypothesis 1

The first hypothesis stated that the personality dimension of Conscientiousness is negatively related to individual performance variability. In this case, the hypothesized relationship between Conscientiousness and individual performance variance was not supported ($r=0.15$, $p=0.09$).

Hypotheses 2-4

The second through fourth hypotheses targeted the relationship between individual performance variability and three of the seven facets of work ethic. The hypothesized relationships were not supported by the data in this case for any of the target facets: Hard Work (r=-0.033, p=0.383), Centrality of Work (r=-0.074, p=0.255), and Wasting Time (r=-0.095, p=0.198).

Hypothesis 5

The fifth hypothesis suggested that cognitive ability, traditionally associated with global performance metrics, would be positively related to individual performance variability. This hypothesis was not supported by the data (r=-0.095, p=0.199).

Post Hoc Analyses

Though only the aforementioned five individual difference measures were hypothesized to be related to individual performance variability, all facets of the personality inventory (NEO-PI-R) and the work ethic measure (MWEP), as well as a number of demographic factors, were assessed. Therefore, post hoc analyses of these variables were conducted to evaluate whether there may be other measures that may have potential to explain employee work performance variability. The results of these analyses follow.

Personality

The NEO-PI-R serves as an assessment of four additional personality factors: Extraversion, Openness to Experience, Agreeableness, and Neuroticism. Correlational analysis revealed significant relationships between employee work performance variability and Agreeableness ($r=0.308$, $p<0.05$), Neuroticism ($r=-0.240$, $p<0.05$), and Extraversion ($r=0.206$, $p<0.05$). These results are articulated in Table 6.

Agreeableness measures an individual's desire to maintain cooperative and harmonious relationships among group members. In this case, a strong relationship between individual performance variability and Agreeableness suggests that individuals who value getting along with others are more likely to exhibit higher levels of performance variability. Neuroticism, as assessed by the NEO-PI-R, evaluates an individual's tendency to be influenced emotionally by problems or stressful situations. In this case a strong negative relationship between Neuroticism and individual performance variability suggests that individuals who are more prone to emotional distress are less likely to vary in their work performance than those who are less affected by troubling experiences. Finally, Extraversion assesses an individual's need for stimulation from the outside world. A relationship between individual performance variability and Extraversion indicates that individuals who are more energetic and outgoing are also more likely to demonstrate performance variability on the job. However, hierarchical regression analysis revealed that the inclusion of Neuroticism and Extraversion, in addition to Agreeableness, did not significantly

improve the prediction of the model (Table 7) due to the collinearity among the three personality facets.

Work Ethic

In addition to the work ethic facets hypothesized to be related to individual performance variability in this dissertation, the MWEP measure used also evaluates four additional facets including; attitudes toward Self-Reliance, Leisure, Morality and Ethics, and Delay of Gratification. The results of correlational analyses did not reveal any significant relationships between individual performance variability and any of the facets of work ethic as can be seen in Table 8.

Demographic Characteristics

Demographic information on the participants assessed in this dissertation was collected including information regarding each individual's age and length of employment with the organization. While correlational analysis, as seen in Table 9, did not support a relationship between age or tenure and an individual's work performance variability, the results did reveal a significant relationship between an individual's tenure with the organization and individual mean performance ($r=0.394$, $p<0.01$). These results imply that while experience is related to an individual's mean-level of performance, individual performance variability does not seem to be affected by maturity or work experience.

Effective Performance

In light of the findings that measures of individual mean-level work performance and individual work performance variability seem to provide important and different information regarding the whole of employee work performance, the interaction of individual performance mean and individual performance variability was derived and used as a criterion measure of an employee's effective performance. This criterion measure was used to discern which individual difference measures might be related to this, potentially fuller, measure of employee work performance. Correlational analyses, as delineated in Table 10, revealed significant relationships between this interaction term and Agreeableness ($r=-0.279$, $p<0.05$), Extroversion ($r=-0.231$, $p<0.05$), Conscientiousness ($r=0.202$, $p<0.05$), and attitudes toward the Delay of Gratification ($r=-0.181$, $p<0.05$). However, hierarchical regression analysis detailed in Table 11, revealed that the inclusion of the latter variables, in addition to Agreeableness, provided no significant improvement to the predictive model. Therefore, all in all, Agreeableness seems to provide the most information regarding individual employee performance variability and its influence on employee performance as a whole.

CHAPTER 6

DISCUSSION

Implications for Theory & Practice

This dissertation demonstrates that, though typically ignored in research, within-subject performance variability does exist, often in substantial amounts at both individual and group levels of work performance. Furthermore, it provides information regarding the prevalence, nature, and influence of employee performance variability in the workplace. According to descriptive statistics assessed in this dissertation it seems that performance variability at all levels is generally normally distributed, with the exception of positive skew at the individual performance variability level indicating that, in this sample, individual variability tends to fall at the lower end of the distribution though more than half (53.6%) of the sample could be categorized as moderate to high variability. This prevalence of employee work performance variability exposes an area of weakness within interdependent systems that historically has been overlooked in process improvement initiatives.

Moreover, it was determined that both individual performance facets: individual mean performance and individual performance variability explain the vast majority of group productivity leaving little room for more typical forms of variability typically emphasized by Operations Management research (e.g., materials defects, equipment performance problems, etc.) to influence productivity. Therefore, future

research aimed toward the elucidation of the causes and resolutions for human work performance variability may provide dramatic benefits for process improvements, and ultimately system productivity.

Further, this dissertation revealed that individual performance variability interacts with individual mean performance and detrimentally influences group level productivity. Specifically, in this case it was found that higher performance variability of work group members seems to constrain the group's productivity to a larger extent than smaller amounts of group member performance variability. Given the negative impact of machine and line variability documented in Operations Management research, it seems the development of a research stream within Industrial and Organizational Psychology directed towards explaining individual differences in performance variability is warranted. Such an approach would not only advance our understanding of human work performance, but also serve to bridge the gap between Operations Management and Personnel research.

However, the sample as a whole did not support the proposed hypotheses regarding individual difference variables and their ability to explain individual performance variability. Therefore, though individual performance variability does seem to exist in amounts that influence both individual- and group-level performance indices, further research is needed to determine whether or not individual performance variability could be related to individual difference variables, or that it may be an individual difference variable in and of itself.

Specifically, post hoc analyses did expose a number of individual difference variables that may prove useful in explaining human performance variability. In particular, the relationship between Agreeableness and employee performance variability should be investigated in future research. Agreeable individuals may be more likely to be influenced by changes in work pace of co-workers or requests to engage in non-production related tasks or activities which would increase their performance variability. Furthermore, the relationship found between Neuroticism and employee performance variability suggests that research should investigate whether individuals prone to emotional response to may feel more anxious or distressed when their work pace or work environment changes and may therefore be more motivated to actively pursue performance consistency. The relationship found between Extraversion and individual performance variability indicates that work environment stimuli (e.g., noise, employee socialization, etc.) may be more distracting for those higher on the Extraversion scale and therefore influences individual performance variability.

A significant challenge to Industrial and Organizational Psychology has been the difficulty of not only defining individual work performance, but also finding consistent predictors of work performance. While constructs like Conscientiousness and Cognitive Ability have offered some headway, these have only accounted for a small amount of the variance in mean performance across individuals. Operations Management research has begun to close that gap in knowledge by incorporating both mean performance and performance variability in explaining true station or line

performance and beginning to look for causes of both mean performance and variability in system performance. This dissertation demonstrates that system performance is influenced by the interaction of employee mean performance and employee performance variability. Furthermore, the post hoc analysis offers a firm foundation to initiate research regarding the individual factors that may cause individual employee variability. Therefore, this dissertation provides evidence that the conceptualization of performance endorsed by Operations Management research may also be applicable to employee performance.

Research is necessary to assess the potential for the further advancement in explaining human performance, namely using additional individual difference metrics to explain better the broader picture of individual performance and its impact on group-level measures. Such an explanation could allow organizations to take a more proactive approach to enhancing organizational productivity by selecting individuals into the organization, using individual difference measures, who will be capable of working at or exceeding a required rate (mean performance), as well as choosing individuals who are more likely able to support a predictable and reliable flow of output (performance variability), increasingly important as organizations struggle to effectively discern reliable and high performing individuals among large applicant pools.

Moreover, considering within-person performance variability as an individual difference itself opens the door to research regarding the extent to which employee performance reliability may be a trainable skill, as well as research into the support

requirements that may be necessary to establish predictable levels of performance across employees. Finally, incorporating individual performance variability as a facet of employee performance may provide a stronger foundation for calculating more accurate and reliable valuation of human resources within organizations.

Limitations

A limitation to this dissertation is the sample size used, as well as the nature of the sample. The small size of the manufacturing facility included in this study limited the sample to only 82 skilled individuals employed within a manufacturing environment that produces relatively complex and varied products on a process layout. It remains to be seen if these findings could be generalized to larger or more routinized assembly line manufacturing layout, as well as to less skilled workforces.

Moreover, further research would need to be conducted to determine if these findings could generalize to the growing service sector. In this dissertation, the performance measures used were objectively derived using electronically monitored measures of time; such performance measures may be difficult to obtain for positions evaluated by more subjective means including human raters (e.g., managers, customers, etc.). For example, the service sector is a setting in which it is more difficult to obtain truly objective and relevant performance information. However, given the service industry's often interdependent nature and primary focus on direct interpersonal interaction between employees and customers, it is a sector that could benefit greatly from this multi-faceted form of performance evaluation.

Furthermore, one emphasis of current operating philosophies, both in the manufacturing and service sectors, is on pursuing the development of performance measures that are more objective and reliable. Therefore, as these types of measures promulgate, analysis like that done in this study will become more applicable. Additionally, Kane's (2000, 1997, 1986) work on performance distribution has made substantial headway in the formulation of a method for measuring individual performance variability in subjectively evaluated positions and provides a foundation on which to begin investigating the consequences and correlates of performance variability, as was done in this study, in less well defined, less-objectively evaluated positions.

Another significant limitation arises from the use of efficiency statistics as the performance/productivity metric in this dissertation. The efficiency statistic is based on an organizationally set standardized time requirement per product that was initially established a number of years prior to this study. While it provides an objective, standardized measure of performance, it is unknown to what extent the possibly outdated standards may be contaminating the efficiency statistics.

Finally, the overall individual performance and coefficients of variation were calculated on a time span of eight weeks, a small amount of time particularly considering that the average tenure of the sample was over 3 years. Studying a longer time span may offer more reliable insight into within-person performance variability as an individual difference variable itself, as well as its relationship to group-level productivity and other individual difference measures.

Directions for Future Study

Despite the limitations, this dissertation offers a beginning point for studying employee work performance from a more faceted perspective than previously considered. While summary indices of individual performance will continue to be important to workforce productivity, the addition of individual performance variability acknowledges the tenet already understood in Operations Management research, that in interdependent systems reliability is as important as, and in some contexts may be more important than, mean performance, in explaining system performance.

Additional research into the correlates of individual performance variability should be conducted, possibly pursuing personality constructs such as Agreeableness, Extraversion, and Emotional Stability that were supported by post hoc analyses in this dissertation. Also, research into individual performance variability and possible correlations with factors such as fatigue or boredom as suggested by Judiesch & Schmidt (2000) could continue to shed light on whether or not individual work performance variability is an individual difference variable itself, an indicator of employee motivation or other individual difference factors, or due to characteristics of the work environment.

Finally, the impact of individual performance variability on a larger sample of interdependent groups, as well as on organization-level effectiveness metrics, should be studied to determine whether the same types of relationships found in Operations Management research also exist when people, rather than machines or systems, are the target of evaluation, as is supported by this dissertation. Replication of these findings

would serve to expand our understanding of individual work performance, allowing for the development of more accurate and useful models of performance, as well as a solid foundation for adapting utility analyses to include the performance variability factor for more precise valuation of employee contribution and more accurate comparisons of the costs and benefits of alternative human resource decisions and interventions.

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APPENDIX

Table 1. Descriptive data individual, aggregated, and group-level means and coefficients of variation.

						Skewness		Kurtosis		Variance Classification		
	N	Min	Max	Mean	SD	Statistic	S.E.	Statistic	S.E.	Low (<0.5)	Mod (0.5-1.0)	High (>1.0)
Individual Mean	82	0.260	1.810	0.878	0.298	0.225	0.266	-0.003	0.526			
Individual CV	82	0.200	1.210	0.567	0.231	0.926*	0.266	0.887	0.526	46.30%	46.30%	7.30%
Aggregated Mean	16	0.590	1.150	0.858	0.161	0.444	0.564	-0.254	1.091			
Aggregated CV	16	0.340	0.810	0.564	0.139	0.005	0.564	-0.459	1.091	18.75%	81.25%	0.00%
Group Mean	16	0.380	1.030	0.804	0.154	-1.048	0.564	2.997**	1.091			
Group CV	16	0.260	0.650	0.495	0.102	-0.544	0.564	0.244	1.091	44.70%	55.30%	0.00%

*Distribution is significantly and positively skewed ($p<0.05$).

** Distribution is significantly leptokurtotic ($p<0.01$).

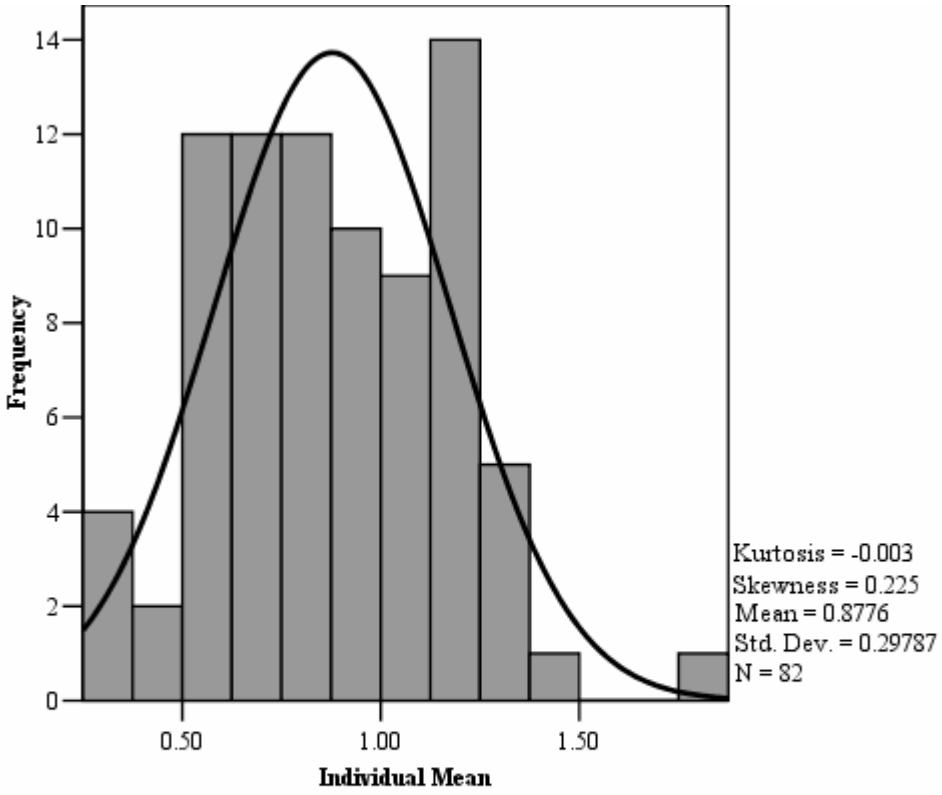

Figure 1. Distribution of Individual Mean Performance.

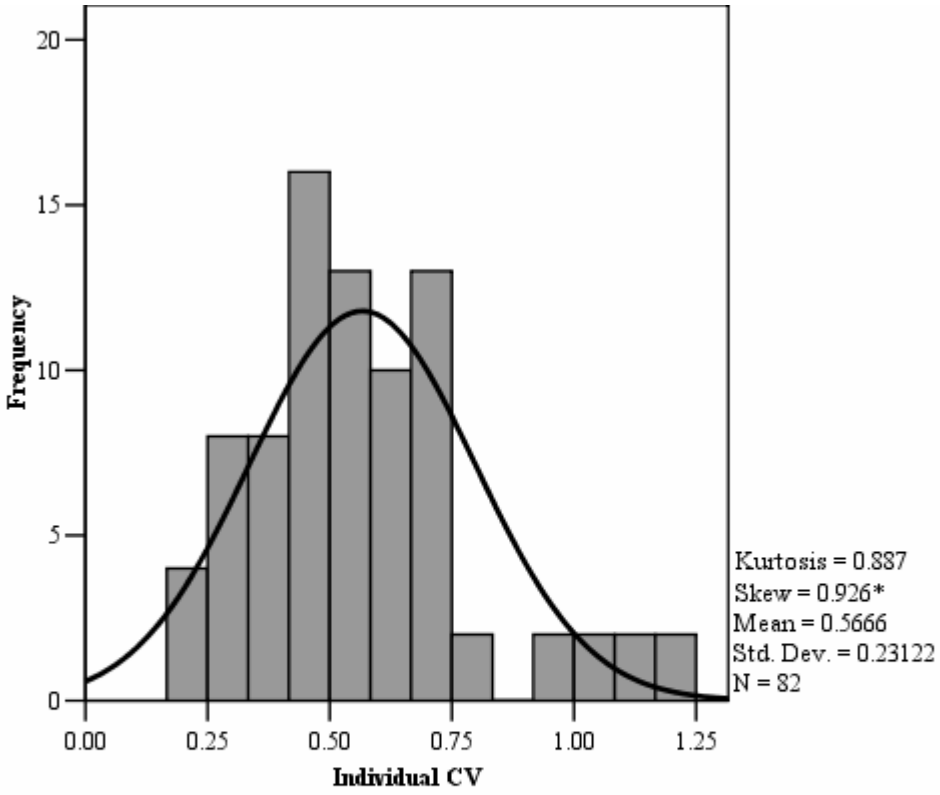

Figure 2. Distribution of Individual Performance Variability.

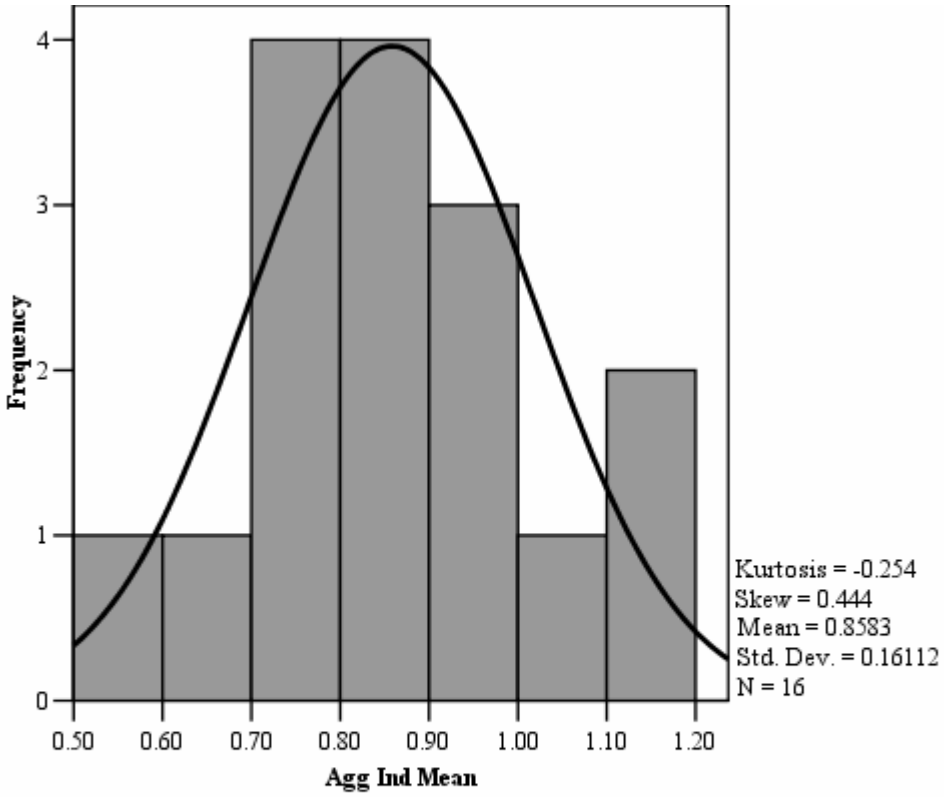

Figure 3. Distribution of Aggregated Mean of Group Members.

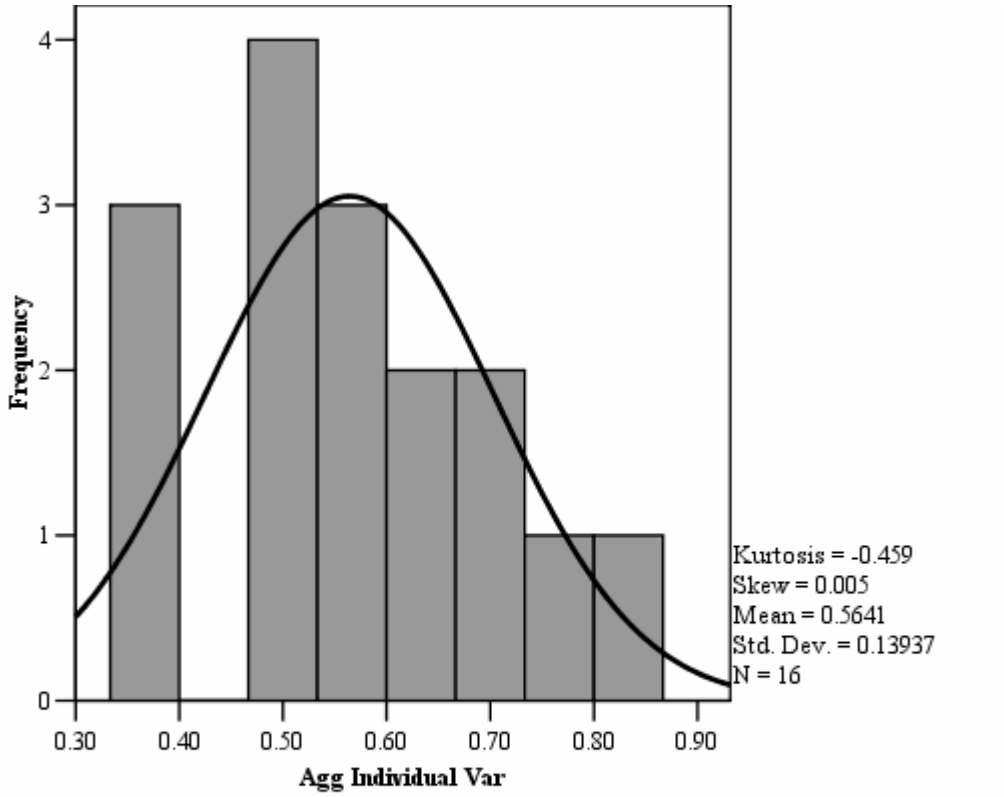

Figure 4. Distribution of Aggregated Individual Performance Variability.

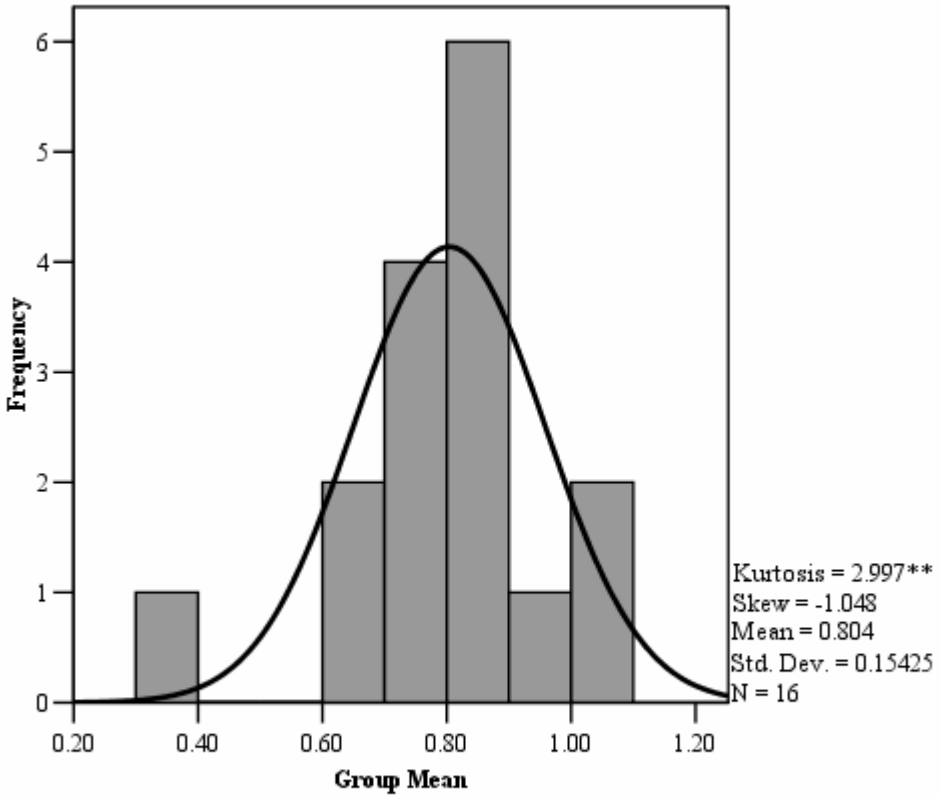

Figure 5. Distribution of Group Level Mean Performance.

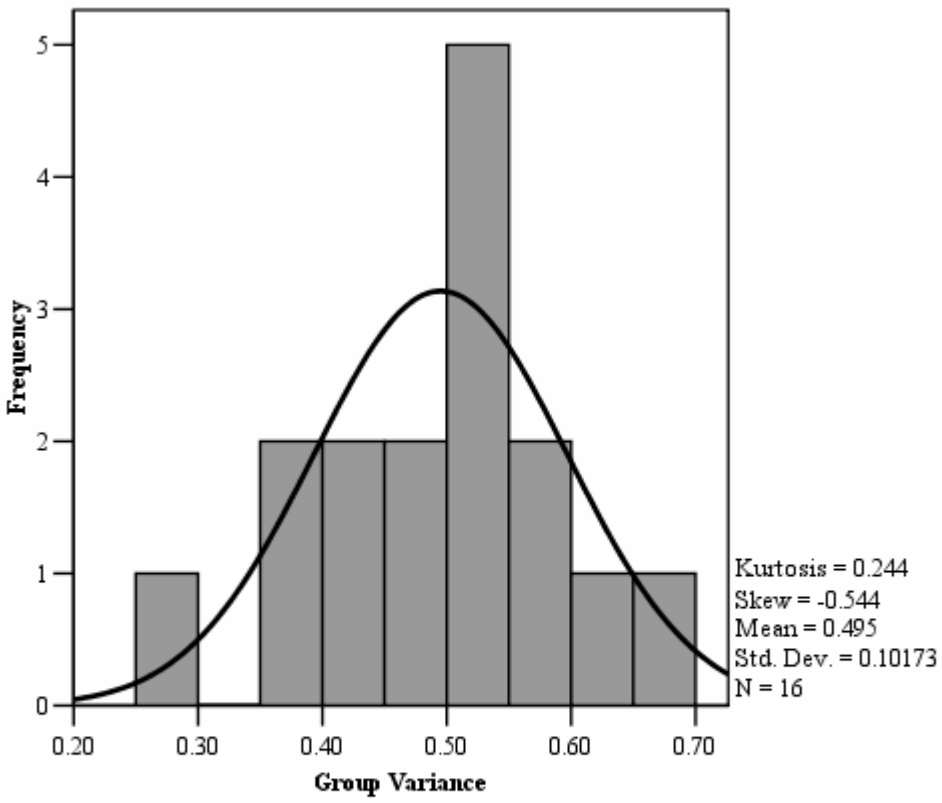

Figure 6. Distribution of Group Level Performance Variability.

Table 2. Correlations among individual means and CVs, as well as aggregated group member variables and group level performance measures.

	Mean	SD	1	2	3	4	5	6
1. Individual Mean	0.878	0.298	1.000	-0.193				
2. Individual CV	0.567	0.231		1.000				
3. Aggregated Mean	0.858	0.161			1.000	-0.205	0.741**	-0.147
4. Aggregated CV	0.564	0.139				1.000	-0.434	0.873**
5. Group Mean	0.804	0.154					1.000	-0.209
6. Group Variance	0.495	0.102						1.000

** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Hierarchical regression analysis of predictive models of group level productivity using aggregate individual performance mean and performance variability.

Model[a]	R	R^2	Adjusted R^2	SE	F	Sig. of F	Change Statistics	
							ΔR^2	ΔF
1	0.741	0.549	0.517	0.107	17.044	0.001		
2	0.795	0.632	0.575	0.101	11.154	0.002	0.083	2.923
3	0.876	0.767	0.709	0.083	13.154	0.000	0.135	6.947*

[a]Model 1: individual mean performance; Model 2: individual mean performance, individual performance variability; Model 3: interaction term included

*$p<.05$

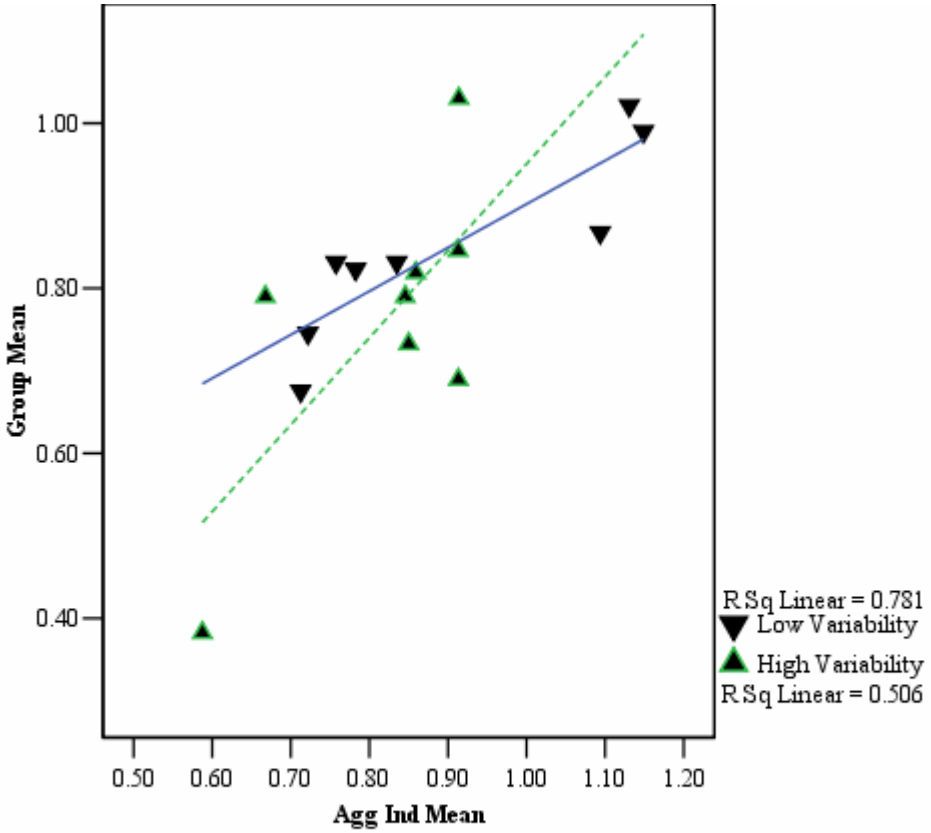

Figure 7. Graphic representation of Aggregate Variability of Group Members on the relationship between Group Mean and Aggregate Mean Performance of Group Members.

Table 4. Descriptive statistics and intercorrelations among Conscientiousness, three Work Ethic facets, Cognitive Ability and individual performance mean and performance variability.

	Min	Max	Mean	SD	2	3	4	5	6	7
1. Conscientiousness	72	168	122.73	22.61	0.396**	0.526**	0.664*	0.120	-0.045	0.150
2. Attitudes toward Hard Work	24	50	37.52	6.53	1.000	0.591**	0.593**	0.213*	-0.065	-0.033
3. Attitudes regarding the Centrality of Work	21	50	37.88	6.25		1.000	0.701**	0.165	-0.112	-0.074
4. Attitudes toward Wasted Time	23.8	50	38.25	5.8			1.000	0.236*	-0.141	-0.095
5. Cognitive Ability	19	35	26.8	4.07				1.000	-0.063	-0.095
6. Individual Mean	0.26	1.81	0.878	0.298					1.000	-0.193
7. Individual CV	0.2	1.21	0.567	0.231						1.000

*Correlation is significant at the 0.05 level (1-tailed).

**Correlation is significant at the 0.01 level (1-tailed).

Table 5. Summary of hypothesized results from Research Question 4.

Hypotheses	r	p-value	results
H1. Conscientiousness is negatively related to performance variability.	0.15	0.090	not supported
H2. Attitudes toward Hard Work are negatively related to performance variability.	-0.033	0.383	not supported
H3. Attitudes toward the Centrality of Work are negatively related to performance variability.	0.074	0.255	not supported
H4. Attitudes toward Wasted Time are negatively related to performance variability.	-0.095	0.198	not supported
H5. Cognitive ability is positively related to performance variability	-0.095	0.199	not supported

Table 6. Descriptive statistics and intercorrelations among NEO facets and Individual Mean Performance and Performance Variability.

	Min	Max	Mean	SD	2	3	4	5	6
1. Individual Mean Performance	0.26	1.81	0.88	0.30	-0.193	-0.088	-0.082	-0.071	0.052
2. Individual CV	0.20	1.21	0.57	0.23	1.000	-0.240*	0.206*	0.00	0.308**
3. Neuroticism	23	134	76.98	24.30		1.000	-0.455**	-0.166	-0.420**
4. Extroversion	11	166	107.56	27.41			1.000	0.487**	0.336*
5. Openness	59	132	107.73	14.80				1.000	0.338**
6. Agreeableness	56	162	117.10	21.42					1.000

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 7. Hierarchical regression analysis of predictive models of individual performance variability and correlated personality facets.

Model[a]	R	R^2	Adjusted R^2	SE	F	Sig. of F	Change Statistics	
							ΔR^2	ΔF
1	0.308	0.095	0.084	0.221	8.404	0.050	0.095	8.404**
2	0.331	0.110	0.087	0.221	4.874	0.010	0.015	1.312
3	0.339	0.115	0.081	0.222	3.366	0.023	0.005	0.422

[a]Model 1: Agreeableness; Model 2:Agreeableness, Neuroticism; Model 3: Agreeableness, Neuroticism, Extraversion

**p<0.01

Table 8. Descriptive statistics and intercorrelations among work ethic facets (MWEP) and Individual Performance Mean and Performance Variability.

	Min	Max	Mean	SD	1	2	3	4	5	6
1. Individual Mean Performance	0.26	1.81	0.88	0.30	1.000	-0.193	-0.060	-0.161	0.117	-0.256*
2. Individual Performance Variability	0.2	1.21	0.57	0.23		1.000	-0.031	0.075	-0.090	0.000
3. Self-Reliance	26	50	36.34	5.99			1.000	0.148	0.160	0.448**
4. Leisure	20	45	32.11	5.39				1.000	-0.285**	-0.107
5. Morality	36	50	45.05	3.79					1.000	0.265*
6. Delayed Gratification	20	50	33.85	6.64						1.000

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 9. Descriptive statistics and intercorrelations among demographic factors and Individual Mean Performance and Performance Variability.

	Min	Max	Mean	SD	2	3	4
1. Individual Mean Performance	0.26	1.81	0.88	0.30	-0.193	0.394**	0.152
2. Individual Performance Variability	0.2	1.21	0.57	0.23	1.000	0.088	-0.120
3. Tenure (in months)	6.51	124.11	38.7	32.75		1.000	0.082
4. Age (in years)	26.36	57.3	40.68	8.04			1.000

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10. Descriptive statistics and intercorrelations among Individual Performance Interaction and NEO and MWEP facets.

	2	3	4	5	6	7	8	9	10	11	12	13
1. Individual Mean* Var.	0.166	-0.231*	-0.279**	-0.202	-0.088	-0.064	-0.149	0.067	0.013	-0.016	-0.075	-0.188*
2. Neurotic	1.000	-0.455**	-0.422**	-0.633**	-0.166	-0.098	0.135	-0.305**	-0.228*	-0.119	-0.060	-0.369**
3. Extrovert		1.000	0.336**	0.517**	0.487**	0.107	-0.114	0.226	0.508**	0.386**	0.394**	0.473**
4. Agreeable			1.000	0.430**	0.338**	-0.163	-0.204*	0.400*	0.073	0.210*	0.102	0.053
5. Conscientious				1.000	0.207*	0.177	-0.290**	0.642**	0.396**	0.526**	0.664**	0.594**
6. Open					1.000	0.265**	0.228*	0.340**	0.298**	0.000	0.270**	0.166
7. Self-Reliance						1.000	0.148	0.160	0.493**	0.175	0.456**	0.448**
8. Leisure							1.000	-0.285**	-0.179	-0.558**	-0.276**	-0.107
9. Morality								1.000	0.483**	0.515**	0.594**	0.265**
10. Hard Work									1.000	0.591**	0.593**	0.595**
11. Centrality of Work										1.000	0.701**	0.448**
12. Wasted Time											1.000	0.639**
13. Delayed Gratification												1.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 11. Hierarchical regression analysis of predictive models of individual performance variability*mean performance and correlated personality and work ethic facets.

Model[a]	R	R^2	Adjusted R^2	SE	F	Sig. of F	Change Statistics	
							ΔR^2	ΔF
1	0.279	0.078	0.066	0.242	6.745	0.011	0.078	6.745*
2	0.315	0.099	0.076	0.241	4.343	0.175	0.021	1.869
3	0.316	0.100	0.065	0.242	2.888	0.782	0.001	0.077
4	0.338	0.114	0.068	0.242	2.487	0.265	0.014	1.258

[a]Model 1: Agreeableness; Model 2:Agreeableness, Extraversion; Model 3: Agreeableness, Extraversion, Conscientiousness; Model 4: Agreeableness, Extraversion, Conscientiousness, Delay of Gratification
*$p<0.05$

VITA

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